DOCUMENT RESUME

ED 258 803 SE 045 799

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TITLE Science for Learning Disabled Students.
PUB DATE 5 Feb 85
NOTE 24p.; For related documents, see SE 045 796-798.
PUB TYPE Reports - Descriptive (141)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Computer Oriented Programs; Curriculum Development; Elementary Education; Elementary School Science; Exceptional Persons; High Schools; Junior High Schools; *Learning Disabilities; Science Activities; *Science Education; *Science Instruction; *Secondary School Science; *Teaching Methods

ABSTRACT

This paper examines various topics and issues related to the teaching of science to learning disabled (LD) students. It includes: (1) an overview of Public Law 94-142, the Education For All Handicapped Children Act and the nature of learning disabilities; (2) a general method for teaching science to LD students (Such as establishing a routine, limiting choices, ensuring that students are attending, giving students cues to facilitate remembering, sequencing instruction, differentiating between teaching and testing, and being specific in criticism and praise); (3) specific suggestions for teaching science to LD students (providing a list of eight LD student characteristics with corresponding classroom modifications); (4) a summary of curriculum development and research efforts, such as the Developing Coping and Cognitive Skills through Science Program and Project ECSEP: The Exceptional Children Science Education Program (an individualized science curriculum for LD junior high school students); and (5) a consideration of microcomputer applications (including a program designed to develop software and assess its effectiveness with LD junior high school students). (JN)

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Science for Learning Disabled Students

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SE 045 799

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Two federal laws stand out as the culmination of legislation that helped ensure a place for handicapped students in American public education: The Education For All Handicapped Children Act (Public Law 94-142) and Section 504 of the Rehabilitation Act of 1973. The implementation of these two statutes require that every handicapped student must be provided the most appropriate education in the least restrictive environment possible. These laws extend to students with specific learning disabilities.

The term "learning disabilities" is used to define a heterogeneous population of students who have difficulty learning. The most widely accepted definition is that which appears as part of Public Law 94-142 (USOE, August 23, 1977). There are two parts to the federal definition. The first part appears in the major body of the rules and regulations and was adopted from a report of the National Advisory Committee on Handicapped Children (1968). The definition reads:

> "Specific learning disability" means a disorder in one or more of the basic psychological processes involved in understanding or using language spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunctions, dyslexia, developmental aphasia. The term does not include children who have learning problems which are primarily the result of visual, hearing or motor handicaps, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage.

The second part of the federal definition is considered to be an operational definition. It appears in a separate set of regulations. Appearing in the special rules and regulations of PL 94-142 that apply solely to learning disabilities, these regulations state that a child can be identified as learning disabled if an evaluation team finds a severe discrepancy between his achievement and intellectual ability in one or more of seven areas: oral expression, listening comprehension,

written expression, basic reading skill, reading comprehension, mathematics calculation, and mathematics reasoning (USOE, December 29, 1977).

Two main points stand out in both definitions: (1) Since learning disabilities does not include learning problems derived from sensory or motor impairments, mental retardation, emotional disturbance or environmental disadvantages, LD students are excluded from the services provided to children with these handicaps; and (2) a discrepancy exists between the LD student's expected achievement and actual achievement.

The LD student, then, is one who has the intellectual potential to succeed in school, but whose academic achievements are significantly below his expected grade level in specific subject areas such as reading or mathematics. An LD student might perform at an average or above level in arithmethic and spelling, but do very poorly in reading or writing. Often this can lead to frustration in the student which is manifested in behavior problems known as failure avoidance techniques. Weary of hearing that he could do better if only he would try, or how could he forget something today that he knew so well yesterday, the LD student begins to display inappropriate classroom behaviors designed to draw attention away from areas of academic failure.

The National Science Teachers Association position statement on science for the handicapped reads, in part, that "...the exclusion of any group or persons from access to science education...is an unnecessary and undesirable waste of human potential" (Coble, 1982, p.60). Yet, the learning problems experienced by LD students impact directly on their ability to succeed in science. Certainly learning science draws upon the skills of reading, writing and arithmetic as well as appropriate classroom behaviors. However, for LD students to receive

an appropriate education in science, classroom teachers and teacher educators must be made aware of different teaching strategies and materials that can be used successfully with LD students.

General Methods for Teaching Science to LD Students

Turnbull and Schulz (1979, pp. 256-271) describe a strategy for the classroom teacher to modify teaching techniques and content material for exceptional students. Their strategy applies directly to teaching science to LD students. In outline form, and adapted to science, teachers should:

I. Assess the student
   A. Identify the present level of performance in science.
      1. Outline for the student the major concepts and skills to be learned.
      2. Give a written or oral test sampling the students' readiness for the content.
   B. Document their reading level in science.
   C. Identify the students' preferred learning style (visual auditory, tactile, or kinesthetic).

II. Adapt the Curriculum
   A. Content
      1. Identify the most relevant material.
      2. Develop short-term objectives.
      3. Sequence the content carefully.
      4. Be prepared for a lack of prerequisite skills for concept development.
   B. Timing - Allow for more instructional time, perhaps through repeated exposure.

C. Instructional Methods

1. Discussion

   a. Be prepared for short attention spans, memory problems, language delays and other behaviors which may distract from discussions

   b. Include <u>active</u> learning such as experiments, games, learning centers, etc..

2. Media - Use pictures, films, charts, displays, etc.

3. Reading

   a. Be careful to avoid "vocabulary loading," that is, reference to unfamiliar and scientific words which have not been introduced and defined earlier.

   b. Be careful to avoid "concept loading," that is, introducing science concepts out of sequence or too rapidly.

   c. Highlight all key words and concepts in reading science materials. Provide outlines and/or graphic organizers for reading material.

4. Doing

   a. Establish a classroom routine that assures a change of pace throughout the day.

   b. In selecting science activities be sure to consider:

      the interest, learning style and abilities of the students

the objectives of the activities

how students work individually and in groups

c. Be willing for students to discover some things for themselves within the structure of the activity.

d. Provide students the essential core of information necessary to cope with the concepts introduced or reinforced by the activity.

The fundamental tenet in education of the learning disabled is the concept of structure. From the earliest authors (Strauss and Lehtinen, 1947) to the more recent (Mercer and Mercer, 1981), authors in the field of learning disabilities have continued to give priority to the concept of providing the LD child with a structured educational environment. Barry (1961, p.21) most clearly defined structure for the learning disabled:

> We mean putting things in order, we mean teaching limits and sequence, we mean clarifying, dramatizing, simplifying, concretizing. We mean bringing the foreground sharply into focus, blocking out non-essentials. We mean touching and feeling, and looking, and listening, outlining, and underlining. We mean performing a simple activity in deliberate, sequential steps, in response to deliberate, sequential commands such as, "Pick it up, look at it, where does it go?, put it there." We mean every technique, device, or trick that will help the child to hear, to see, to understand-to take meaning out of chaos-for until we structure the world for some of these children, it is just that-chaos.

The rationale for a structured educational environment stems from the perceptual and cognitive difficulties of the learning disabled student who cannot mask out unnecessary stimuli (background sights and sounds) to respond to the task at hand. Structure sorts out the

extraneous data and allows the student to use his abilities without interference from his disabilities. Ways to promote structure have been suggested by numerous authors (Strauss and Lehtinen, 1947; Kaliski, 1959; Barry, 1961; Barsch, 1965; Wallace and Kauffman, 1973; Lerner, 1981; Mercer and Mercer, 1981; Siegel and Gold, 1982). Those most pertinent to the general educational setting are presented below:

1. Establish a routine. Smith (1978, p.3) states that "For learning disabled children, the ability to organize has somehow been short-circuited and normal learning cannot follow." The teacher who is well organized and consistent provides an immediate model. Further, anxiety is reduced because the LD student knows what to expect and when, from calling the roll to presentation of tomorrow's assignment.
2. Limit-choices. While it is democratic to give choices, initially teachers should tell the LD student specifically what he is to do. Situations of implied choice should be avoided as well. To begin with "Would you like to..." implies choice, and becomes very confusing to the student who responds contrary to what is going to happen anyway. If he is going to be moved to the front of the room, why ask him if he "would like to sit here". Expand decision-making opportunities only as he exhibits capability..
3. Ensure that the student is attending. While there are no foolproof means of determining task attending, there are some techniques which are rough measurements such as: asking the student to repeat presented information, requesting a response to a question, requiring completion of a motor task (assuming that he has the skill in his repertoire), or assessing maintenance of eye-contact. These are considered rough measures of attending because per-

ceptual difficulties may interfere, for example, using eye-contact as a measure of attending with a student who listens better when visual focus is averted. However, measuring may become a means of improving attending skill because the student may use the measure as a means of guiding attention.

4. Give the student cues to facilitate remembering. Cues include mnemonic devices, rhymes, words within words, cognitive clues, visual associations, auditory associations, linking associations, and any other aid to support recall. An example of mnemonic use in science is the name S.P. COHN to remember the elements of protoplasm. LD students often devise their own cues, some of which facilitate recall, some of which confuse the learner. Teachers should check the reliability of student-designed cues and refine the system when necessary. Teacher-designed cues should be concrete, easier than the task itself, and within the student's repertoire.

5. Sequence instruction. Sequencing instruction is a form of task analysis which enables the teacher to set goals and organize instruction so that the LD student can experience continued success. The sequence of instruction answers the four "w' of teaching; what to teach, where to begin, when objective has been attained, and what to teach next. Sequence for LD students should also include how information is to be taught. An excellence reference for sequence of instruction is Competency Goals and Performance Indicators K-12 which is published by the North Carolina Department of Public Instruction. This publication includes goals and indicators for all content areas.

6. Differentiate between teaching testing. For the LD student, assignments, presented as reinforcement activities , actually may be evaluating and not reinforcing. Requiring an LD student to complete a task in the absence of instructional assistance such as models, cues, prompts, or correct answers is testing, not teaching, and for the LD student is a sure way to maintain his failure rate. Addition of an example at the top of a worksheet, or a set of guiding questions can transform the assignment into a maintenance task.

7. Be specific in criticism and praise. The LD student lives in a hit or miss world. When he is correct, the world rejoices; when he is incorrect, the world mourns. But, no one tells him specifically why his response is correct or incorrect. The note on his paper indicating improvement should specify why today's paper is improved over yesterday's. By the same token, his errors should be pointed out in a specific manner. To send an LD student back to his desk to "look at number five, again" is setting him up to make an error in a different way. He will change his answer, even the parts he had correct on the first attempt.

8. Provide visible time clues. Typically, the LD student is disoriented temporally. He has difficulty remembering chronological sequences, estimating time intervals, judging time needed to complete tasks, and occasionally, learning to tell time beyond the hour and half-hour. An obvious aid is a classroom clock with Arabic numberals. Schedules placed on the bulletin board, or taped to the inside cover of his notebook will be visible reminders of daily events. An assignment book with a systematic procedure for recording daily assignments, test schedules, due

dates for projects and special events should be implemented. Recording procedure should include the entry "no assignment" for days when none is given. The book should include Saturday and Sunday to help develop chronological sequence.

9. Confer with the LD teacher. Successful programming for the LD student depends on continuity of content and consistency of management techniques. The role of the LD teacher is to suggest modifications and provide concrete examples of what may be done, including materials (Gearheart and Weishaahn, 1984, p.219). Incorportation of the suggestions, however, is at the command of the classroom teacher who knows how appropriate they may be for the ongoing program. Communication between generalist and specialist is essential to the academic achievement of the student. It ensures similarity of content concepts being taught and avoids conflict of acceptable behavior standards.

10. Develop empathy. Demonstrate sensitivity to LD student's attempts to learn, to remember, and to conform. Respect him as a person and point out his abilities. He is well aware of his disabilities, but, equally unaware of his abilities. This is not surprising, for usually it is his disabilities which become the focus of attention. Cohn (1979, p.53) reminds us that "students who feel that others do not respect them are less likely to respect themselves."

Specific Suggestions for Teaching Science to LD Students

Since the seven specific learning disabilities listed in PL 94-142 are primarily related to the basic skill subjects, less attention has been given to suggestions for teaching science and other content areas. Emphasis has been on remedial strategies rather than metacognition and

the entire range of academic needs. To ignore the role of content areas is to ignore the capabilities of the LD student and the possible contributions of the content subjects. Science, for example, uses a multisensory approach with a highly structured format. Scientific principles are consistent and the regular cycles of many natural phenomena are predictable. Both the approach and the structure provide a viable learning environment for the LD student. Seigel (1982, p.260) states that effective teaching of science holds many positive implications for the LD student. According to Seigel, science can replace misconceptions about the environment with understanding, provide leisure time activities such as collecting rocks, improve social skills through group participation, reinforce a sense of structure and sequence, and develop understanding of individual differences. Further, Seigel notes that the field of science has vocational implications for the LD student since it is related to a large variety of occupations and professions. He also suggests that science can improve perceptual and motor skills since many activities involve using two or more perceptual areas at the same time.

Teachers must have hands-on experience with the materials and activities to be presented to LD students in order to anticipate and avoid problems. Seigel reviewed the perceptual, motoric, cognitive and behavioral characteristics generally attributed to LD students and suggested modifications to offset what he refers to as "pitfalls." Although his list is by no means exhaustive, it does establish a starting point for the science teacher who is faced with the responsibility of teaching science to students with learning disabilities.

The following correlations between LD student characteristics and science class modifications are adapted from Seigel (1982, p.262):

LD Student Characteristic	Suggested Classroom Modification
1. The LD student may lack coordination: drop equipment, cut self using strippers.	Use plastic containers; teach use of of wire strippers
2. Equipment and material may distract the implusive student.	Clear desk of extraneous equipment. Use one item at a time and collect each after use.
3. Impressed with the end-product, the LD student misses the scientific concept.	Ask questions which emphasize cause-effect relationships. Ask a series of sequential questions.
4. His generalizations may be incorrect.	Anticipate possible misconceptions and discuss differences before he makes errors.
5. The LD student may have difficulty comprehending abstract terms and concepts.	Begin at the concrete level and move step by step to the abstract level. Use demonstrations, models, and pictures.
6. He may have a specific reading disability.	"Rewrite" the text using a highlighter to emphasize important information. Have volunteers tape the textbook.
7. The LD student may lack exploratory drive.	Use forced choice strategies.
8. The LD student may explore in a random, purposeless manner.	Use direct teaching which is highly structured.

Curriculum Development and Research

A recent project in Greenville, N. C. resulted in a curriculum that was designed to help both regular and special education teachers learn to work effectively with children with specific learning and behavior problems in non-categorical settings: Developing Coping and Cognitive Skills Through Science.

This program consists of a collection of independent science activity kits (SAK's), each concerned with a different topic in science and requiring from 4 to 8 weeks to present, depending on the module itself, the students' ability, and the frequency of instruction. The SAK's are primarily designed to be used in grades 4-6 by regular teachers with heterogeneous classes containing some mainstreamed exceptional children. The program has also been used successfully with educable mentally handicapped, learning disabled, emotionally handicapped, low functioning, regular and gifted children in grades 4-8 in a variety of class sizes and situations with both heterogeneous and homogeneous groupings of students (Coble, 1982).

One reason for the program's flexibility is that each activity can be presented on three different ability levels which are based on Frank Hewett's model of psychological development. There are numerous ways in which teachers can utilize the three levels. In general, teachers select the level most appropriate for the majority of the students and then use the other two levels as required with individual students in a science center or with small groups.

The lesson presentations in the teacher's manuals are explicit, including the objectives, a list of materials and supplies, special instructions, performance evaluation criteria, worksheets for the three levels and even suggested dialogue for introducing and discussing each activity. Teachers can prepare IEP's from the information in the manuals.

Modules may be purchased separately and used in any sequence at any of the three grade levels appropriate to the school's curriculum; modules may be used supplementary to the text, or as a total curriculum for the topics available. Materials and supplies lists are available for

each SAK, with suggested vendors and approximate costs of individual items. Teachers can share SAK's, enabling a school to package only one kit per module.

The SAK's have been fieldtested, reviewed by an advisory committee composed of experts in both science and handicapped education, and evaluated. For further information, write:

Wende Allen, Science Coordinator
Northeast Regional Education Center
P. O. Box 1028
Williamston, N. C. 27892
919-792-5166

An individualized science curriculum for learning disabled junior high school students was recently developed in Charlotte N. C.: Project ECSEP: The Exceptional Children Science Education Program is a program based on investigative inquiry in design. Each packet contains: a teacher's guide, study workbook, flash cards, concentration cards, filmstrip/cassettes with student reading script, evaluative exercises, and equipment/materials lists for items provided and those secured by the teacher. Since the packets are designed to be used on a self-paced basis with one or two students, the length of time for each may vary from as little as six hours to more than ten hours. The goals of Project ECSEP are as follows:

1. To help the secondary science teacher meet the needs of learning disabled students by providing materials especially designed for their use.

2. To help the learning disabled child by stimulating interest in and positive attitudes toward science by utilizing hands-on, activity oriented experiences.

3. To help the learning disabled child by providing materials suitable for a variety of learning channels.

4. To help the learning disabled child develop new science skills, better understanding of science processes and higher levels of retention of concepts (Vizzini, 1982).

For further information, write:

Charles Vizzini, Science Specialist
701 E. Second Street
P.O. Box 30035
Charlotte-Mecklenburg Schools
Charlotte, N. C. 28230

In other cases, existing science curricula were used with LD students in the elementary school and secondary school. Esler (1979) used the "Sink or Float" unit of the Elementary Science Study with a group of LD students in Florida. These students were pretested and posttested with the Peabody Individual Achievement Test (PIAT) and selected Piagetian developmental diagnosis tasks. The developmental tasks tests showed an appreciable change in the number of children who were judged to be conservers. Improvement by the students was also noted in three of four PIAT subjects--mathematics, reading and spelling.

Slavin described a high school biology program for LD/EH students that utilized Ginn's ISIS (Individualized Science Instructional System) curriculum. Slavin's study (1979) showed that students were more successful in a classroom situation where a regular classroom teacher and a resource room teacher worked together with a group of 15 LD/EH students. By comparing data on tardiness, absences, dropouts, failures and successful completion of the course, the CRT (Classroom Resource Teacher) was found to yield superior results compared to mainstreaming and partial mainstreaming. The assumption in organizing the CRT Biology program was that budgets would allow for small classes and the use of the resource room teacher with the regular classroom teacher. A fringe benefit to the teachers was the opportunity of developing excellent working relationships between the science teachers and the resource teachers (Slavin, 1979, pp. 164-70).

One of the approaches to teaching science to LD students involved a

system where students would choose from several things to do each day when they came to class (Franz, 1979, pp. 36-38). Students chose from the following options: learning activity packets, independent study, laboratory activities or discussion, and non-reading activities. During a particular class period, students typically spent about half of the time working on a learning activity packet and the other half on one of the other activities. Franz stated that when students enrolled in the class, they simply wanted to pass the course. The goal of the teacher was to motivate the students to want to come to class and work. The grading system rewarded students substantially for class attendance and their active participation and work during class. Franz felt that the obvious success of the program was related to its four main characteristics. "First, practical subject matter, which lends visible relevance to science; second, the numerous choices available to students, which helps to make them feel responsible for their own learning; third, self-pacing, which gives students a greater chance to succeed; and fourth, the point system, which gives immediate rewards for productive work" (Franz, 1979, pp. 36-38).

Ornik (1976) advocated using a system of "contract teaching" in working with LD students. The contract system was advocated for self-contained classrooms and mainstreamed classrooms. The success of contract teaching with LD students was dependent on careful planning and evaluation of the contract in an effort to provide motivation to study science for these special students.

Rice (1983) discussed the merits of having LD students work on science fair projects and came to the conclusion that the science fair was an excellent technique for working with LD students. A strong feature of the science fair of having regular and special education

students working in the same activity gave teachers a chance to understand the strengths, weaknesses, and learning styles of all children. Almost 50% of the science fair winners came from the learning disabled class.

Two projects in the state of Delaware developed science materials for learning disabled students. A general biology course was developed at St. Marks High School by Wheeler (1973). Student participation was emphasized. Students chose the number of activities to complete in each unit of study. The other project in Delaware developed supplementary kits for individualized instruction (Hopkins, 1973). The purpose of the kits was to facilitate the teaching of basic science skills in regular classrooms or classes of learning disabled students.

A Title III ESEA Project in Nebraska developed curriculum modifications for language learning disabled students in the elementary school (Owens, 1974). This project used a curriculum modifier (a consultant to teachers) that performed functions such as preparing individualized prescriptions and selecting appropriate instructional materials. The science portion of the project was a model unit on plant growth.

Ball (1978) developed a teacher's guide for using some of the ESS modules with special education students. A distribution chart indicates the grade level and specific disabilities capable of using each ESS unit. Comprehensive multimedia materials catalogues have been published at the Hillside School in Cushing, Oklahoma in 1978 and 1981. These catalogues present more than 920 annotations for resources to be used in resource rooms for learning disabled students. Science is one of the areas that is covered by these catalogues.

Microcomputer Applications

An extension of Project ECSEP described earlier was recently funded by the Learning Disabilities Foundation of America to develop the computer software for the seven modules that have been developed by Project ECSEP. The purpose of this research project at East Carolina University is to assess the effectiveness of computer assisted instruction in science for learning disabled (LD) students at the middle school level. The appropriate use of small computers with LD students will be the main test effect.

The project has the following objectives:

1. To develop the necessary software to allow learning disabled students to utilize the Apple II plus and TRS-80 Model III microcomputers in the tutorial and evaluation phases of the middle school school level Exceptional Children's Science Education Project (ECSEP) materials.

2. To assess the cognitive gains in science on locally developed, computer-administered assessment instruments for middle school learning disabled students.

3. To compare the differences in cognitive gains and retention in science between LD students using the microcomputer and those not using the microcomputer with the ECSEP materials.

4. To assess the attitudes of middle school LD students toward the use of microcomputers as a learning aid in science.

5. To assess the attitudes of science teachers toward the use of the microcomputer as a learning aid for their LD students.

For further information, write:

Floyd Matthe[illegible] Project Director
Department of S[illegible]ience Education
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The educational and scientific literature confirms that the microcomputer is a powerful learning aid to students in general. Computers can be extremely useful when doing what they do best, which is to store, organize and process information and to carry out a wide range

of repetitive tasks very rapidly. The particular Computer Assisted Instruction (CAI) functions most useful are (1) drill and practice, (2) tutorial and (3) simulation. The excellent characteristics of using CAI is that the computer never gets tired or bored and it can (if programmed properly) adjust to the student's level and speed. Student performance can be automatically monitored, recorded, evaluated, and stored for future reference by the student or by the teacher. Record keeping and paper work can be reduced for the teacher.

There are numerous reports of educational gains associated with the use of microcomputers (Souviney, 1980 and Aiken & Brawn, 1980). Cox and Berger have reported on the increased motivation of students using microcomputers as a learning aid in science. In addition, Cox and Berger noted significant gains made by low achieving students (1981). There are other projects that are making use of the microcomputer to help the physically handicapped (Lunney, et al, 1980). However, specific data related to the usefulness of the microcomputer as a tool for helping LD students achieve in science is noticeably missing from the literature. There is a clear need to apply this new technology to aid in the remediation of the specific disabilities of LD students and to determine its effectiveness.

A recent book that outlines microcomputer resources for special education is now available. The three main divisions in the book are communication, on-line services, and instruction. The book Microcomputer Resource Book for Special Education, is published by Reston Publishing Company, 11480 Sunset Hills Road, Reston, Virginia 22090.

Another recent publication is The Specialware Directory which lists and describes commercially produced software/courseware that is

useful for special education. The 1983 directory is 61 pages of source documentation and can be ordered from: LINC, 1875 Morse Road, Suite 215, Columbus, Ohio 43229.

Closing the-Gap is a new periodical that is published six times yearly and is devoted to computers and the handicapped. The publishers are Budd and Delores Hagen, P. O. Box 68, Henderson, MN 56044.

Summary

The curriculum projects and microcomputer applications described here clearly demonstrate that LD students can learn the same science that non-handicapped students are expected to learn. However these successful projects also demonstrate that a knowledge of the LD learner must be accompanied by modification in the curriculum and in the teachers' instructional strategies. Both the art and science of teaching must be fully engaged to achieve success in teaching science to LD students.

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